

Study program: Mechanical engineering			
Type and level of studies: Bachelor studies			
Course unit: Heating systems			
Teacher in charge: Rade Karamarković			
Assistant: Dragiša Šimunović			
Language of instruction: English			
ECTS: 6			
Prerequisites: Basic knowledge of engineering thermodynamics			
Semester: Winter semester			
Course unit objective: Learning students to design central heating systems.			
Learning outcomes of the course unit			
Students should acquire the knowledge about: the calculation of physical parameters of building envelopes, and heat losses, the design of two-pipe gravity heating systems, the design of two-pipe, single pipe, and panel heating, balancing of hydronic heating systems, Calculation of main elements of boiler rooms and thermal substations, and basics of district heating.			
Course unit contents			
<i>Theoretical classes</i>			
Thermal comfort. Calculation of heat losses. Types and choice of heating devices and systems. Types of heating appliances. Thermosyphon heating systems, pipe dimensioning. Forced circulators in central heating systems. Sizing and balancing of systems: two-pipe and single-pipe heating systems. Panel heating: types, characteristics, sizing of heating panels, and dimensioning of the pipe network. Calculation of main boiler room elements: hydraulic switches, expansion vessels, safety lines, safety valves, and chimneys. Balancing of hydronic central heating systems. Low-pressure steam heating: types of systems, their usage, sizing distribution, and condensate lines. District heating systems: types, main elements, and tendencies. Calculation of thermal substations: heat exchangers, regulatory and safety armature.			
<i>Practical classes</i>			
In parallel with theoretical classes, students do numerical examples. In addition, students will be trained to use software for the design of central heating systems. Visits to a district heating company. Laboratory exercises (3): determining the thermal conductivity of an outer wall, measurement of water speed in pipelines, and balancing a hydronic system.			
Literature			
1. B. Todorović. Design of central heating systems. Faculty of mechanical engineering in Belgrade. Belgrade 2010.			
2. R. Karamarković. ppt lectures and numerical examples.			
3. VDI Heat Atlas, 2010			
Number of active teaching hours			Other classes
Lectures: 30	Practice: 30	Other forms of classes: 5	Independent work: 10
Laboratory exercises			
Teaching methods			
Theoretical lectures and auditory exercises with computational examples. Field visit to a district heating company. For a given building student calculates heating requirements, analyzes energy efficiency improvement, and designs: two and one-pipe heating systems with radiators, panel heating system, and determines components in the boiler room.			
Examination methods (maximum 100 points)			
Exam prerequisites	No. of points:	Final exam	No. of points:
Student's activity during lectures	10	oral examination	40
practical classes/tests		written examination	
Seminars/Homework		
Project	50		
Other			

Grading system		
Grade	No. of points	Description
10	95-100	Excellent
9	85-94	Exceptionally good
8	75-84	Very good
7	65-74	Good
6	55-64	Passing
5	Less than 55	Failing